Substitute Specification:

--APPARATUS FOR EQUIPPING SUBSTRATES WITH ELECTRICAL COMPONENTS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention generally relates to apparatuses for equipping substrates with electrical components. In particular, the present invention relates to apparatuses using a moveable equipping head for handling electrical components.

Discussion of the Related Art

Basic devices of this type have been generally disclosed. For example, in US 4,875,285, a turret-like equipping head has a large number of grippers constructed as suction pipettes, which picks up components at the feed locations. From there, the equipping head moves to a printed circuit board which is fixed in the apparatus and onto which the components are placed successively. In this case, the number of components transported is restricted to the number of suction pipettes. After the placement action, the equipping head must be moved again to the feed devices arranged outside the equipping area.

It is notable that large components, for example multi-pin ICs, cannot be handled by the turret head for reasons of space, and such turret heads usually have only one gripper with which only one large component can be transported in each case.

SUMMARY OF THE INVENTION

The present invention is based on the object of increasing the equipping performance with a low constructional outlay.

This object is achieved by the equipping head with a storage element according to the present invention. The storage element can be designed to be sufficiently large that it is able to accommodate a large number of components. In this case, the equipping head in the area of the feed devices picks up components until the storage element has been filled. Then, the equipping head moves over the substrate to be fitted, where the gripper removes the components from the storage element and places them successively onto the proper locations. An equipping head of this type needs only a single gripper for filling and emptying the storage element. Since, only low relative movements take place between the gripper and the storage element, these operations are able to proceed quickly, similar to that in the turret head.

In mechanical terms, the storage element can be configured more simply than the grippers of the turret head. In addition, the storage element can be kept so large that it accommodates a considerably larger number of components, as a result of which the equipping head has to move less often between the feed devices and the substrate.

In one embodiment, the components can be transported between the gripper and the storage element in simple movement sequences.

The pivoting part as provided in a further embodiment provides an easy relative movement of the gripper between the placement and the transfer position.

In another embodiment, the component can easily be fetched from the feed devices, transferred to the storage element, removed from the latter, and placed onto the substrate.

In a further embodiment, the transfer between the gripper and the storage element can be controlled in such a way that the component is held safely in every phase.

In another embodiment, the action of positioning the components is simplified. It is possible to use a sensing device, for example an optical sensing device, to determine the position of the components to one of the stepping positions. Since the transferring of the components from the sliding part to the gripper is carried out in a defined manner, it is possible to use the position data obtained from the sensing device to correct the angle and position of the components.

Also, suction openings can be provided with the sliding part so as to constitute simple holding means for the components on the sliding part. This provides a way for the components to be held and transferred on the sliding part in a simple way. The sliding part can also be provided in the form of annular design being rotatably mounted, which readily permits vertical placement of the components onto the storage spaces or onto the substrate.

Accordingly, the operations of fetching components from the feed devices and filling the storage element can be accelerated, in that in each case, one of the grippers is located in the fetch position and another gripper is located in the transfer position. In the same way, the actions of emptying the storage element and equipping the substrate are also accelerated.

In another embodiment, two grippers in a pendulum-like movement, alternately assume the placement position and the transfer position. In this case, however, each individual gripper must be assigned its own transfer position. In the case of a sliding part which is concentric with the placement position, this can be implemented in a

straightforward manner by the two transfer stations being located diametrically opposite each other. A filling cycle can then be carried out with half a revolution of the sliding part, each of the two grippers filling one half of the ring.

In another embodiment, the pivoting part can be indexed in a rotational movement without any change of direction. Since, the grippers are no longer primarily used for storing the components, the number of grippers can be reduced to the number of working stations provided without any loss in performance. If, in addition to a placement station and a transfer station, a sensing and a rotation station are further provided, only four grippers would be needed.

In another embodiment, the working stations are being provided along a circulation path of the grippers, on a stator of the equipping head. Here, at least one of the working stations form the transfer station. Accordingly, components can be transferred at the clock rate of the equipping head without any loss of time.

By placing a sensing station between the transfer station and the placement station, it is possible to perform positional control and position correction of the components following removal from the storage element, and directly before the last handling step of the placement onto the substrate.

By using an additional storage element, storage capacity can be increased considerably. In the case of a turret-like equipping head, it is easily possible to assign a second transfer station to a previously unused holding station.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows in schematic form an equipping head having two grippers;

Figure 2 shows the equipping head according to figure 1 in a different working phase;

Figure 3 shows a side view of an equipping head with grippers arranged in a turret; and

Figure 4 shows an end view of the equipping head according to Figure 3.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Figure 1, an equipping head 1 can be moved in the direction of the indicated arrows X and Y in two coordinate directions by means of a positioning system (not illustrated), between feed devices and a substrate. Feed devices of this type have, mutually parallel component tapes 2, having pockets in which electronic components 3 are held. By means of stepwise displacement of the component tape 2, the pockets can be displaced into a fetch position, in which a respective component 3 can be removed from the component tape 2 in the indicated vertical arrow direction by a gripper 4, by suction.

Gripper 4 is guided in a pivoting part 5 and can be displaced in the fetch direction, perpendicular to the plane of movement. It is lowered with its holding end onto the component, which is lying in a ready position and arrives in the active range of a suction channel of the gripper 4. By means of withdrawing the gripper 4, the component 3 is removed from the component tape and lifted into the transport position illustrated in Fig. 1.

The pivoting part 5 can be pivoted about a horizontal axis 6 in accordance with the circular arrow S. It has a second gripper 4, which is arranged in a V-shape with

respect to the other gripper 4 in the pivoting plane of the pivoting part 5, in such a way that the longitudinal axes of the grippers 4 meet at the center of the axis 6.

In addition, the equipping head 1 has an annular storage element 7 which is concentric with the vertical gripper 4, and is provided with an annular sliding part 8 mounted on a stationary annular part 9 of the storage element 7, such that it can be rotated in the direction of rotation arrow D. A free inner side of the sliding part 9 is of conical design and provided with suction openings 10, which are arranged such that they run around at uniform pitch spacings. Suction openings 10 define storage spaces 11 for the components 3.

Pivoting part 5 can be pivoted between stops 12 belonging to the equipping head 1 in such a way that in each case, one of the grippers 4 is located in the vertical fetch position, and the other gripper is located in an oblique transfer position in which it is assigned to a transfer station 19 of the equipping head 1. At the same time, the sliding part 8 is rotated into a position assigned to one of the free storage spaces 11, likewise belonging to the transfer station 19. Gripper 4 is oriented perpendicular to the storage space 11. By means of a vertical placement movement of gripper 4, the previously fetched component 3 can be deposited on the storage space 11 of the sliding part 8.

During these transfer operations, pressure relationships in the suction opening 10 and the suction channel of the gripper 4 can be controlled in such a way, that the component 3 is held securely in every phase and can be transferred without being offset laterally.

By means of pivoting the pivoting part 5, the free gripper 4 can then be pivoted into the fetch position, and the other gripper 4 is moved into a different transfer position, in which it is assigned to a further transfer station 19 located diametrically opposite the

other. Sliding part 8 is cycled in such a way that in each case, one of the storage spaces 11 is located in the transfer station 19, and the storage element 7 is already completely filled after half a revolution of the sliding part 8.

Then, according to Figure 2, the equipping head 1 can be moved in an equipping area of the equipping apparatus above a substrate 13, onto which the component 3, in a movement sequence which is the reverse of that for filling, is removed successively from the storage element 7 and placed onto the substrate 13.

According to Figures 3 and 4, a large number of grippers 14 are arranged on a rotor 15 mounted on a stator 16 of another equipping head 17, such that it can be rotated step by step. Various angular positions of the grippers 14 are associated with different working stations. These are, constructed as a placement station 18, a transfer station 19, a sensing station 20, and a rotating station 21.

In the placement station 18, the components 3 are removed from the component tape 2 and, in two steps, are pivoted as far as the transfer station. Located at their level is the annular storage element 7 having the conical sliding part 8 on whose storage spaces 11 the components 3 can successively be placed. After these locations have been filled, grippers 14 of the rotor 15 can be populated with additional components 3 in a further cycle such components may be less suitable for intermediate storage in the storage element 7than the components 3 previously considered.

Equipping head 17 then moves until it is in a position above the substrate 13 to be fitted, as shown in Figure 4. Here, the components 3 located on the grippers 14 are placed onto the substrate 13 in the placement station 18. During this cycle, the precise position of the components 3 is determined in the optical sensing station 20. In the following rotation station 21, the angular position of the components 3 is corrected by

rotating the gripper 14 about its longitudinal axis, which is arranged such that it is vertically radial with respect to the axis of rotation of the rotor 15.

As soon as grippers 14 which have become free reach the transfer station 19, they successively remove components 3 from the synchronously corotating sliding part 8 of the gripper 7 and, after passing through the sensing station 20 and rotation the station 21, place said components 3 onto the substrate 13. After all the components 3 have been placed onto the substrate 13, equipping head 17 can be moved over the feed devices for a new fetch cycle.

It is possible to provide the equipping head 17, with at least one further storage element 7 and one further transfer station, as indicated by dash-dotted line in Figure 4. Thus, the storage capacity of the equipping head 17 can be increased appropriately.

Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.--

~~Description~~ **Substitute Specification:**

~~Apparatus for fitting~~**--APPARATUS FOR EQUIPPING SUBSTRATES WITH ELECTRICAL COMPONENTS**

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention generally relates to apparatuses for equipping substrates with electrical components**. In particular, the present** ~~The~~ invention relates to ~~an apparatus for fitting substrates with electrical components by means of a moveable fitting head for handling the components, which can be picked up at feed devices by at least one gripper belonging to the fittinghead, transported to fittinglocations on the substrate and placedonto the substrate ther~~ **apparatuses using a moveable equipping head for handling electrical components.**

~~A device of his type has been disclosed, for example, US4,875,285. A fitting head like a turret~~ **Discussion of the Related Art**

Basic devices of this type have been generally disclosed. For example, in US 4,875,285, a turret-like equipping head has a large number of grippers constructed as suction pipettes, which ~~pick~~ **picks** up ~~the~~ components at the feed ~~devices~~ **locations**. From there, the ~~fitting~~ **equipping** head moves to a printed circuit board which is fixed in the ~~appratus~~ **apparatus** and onto which the components are placed successively. In this case, the number of components transported is restricted ~~tothe~~ **to the** number of suction pipettes. After the placement action, the ~~fitting~~ **equipping** head must be moved again to the feed devices arranged outside the ~~fitting~~ **equipping** area.

It is ~~particularly the case~~ **notable** that large components, for example multi-pin ICs, cannot be handled by the turret head for reasons of space~~. Provided for such components are heads having~~**, and such turret heads usually have** only one gripper~~,~~ with which only one **large** component can be transported in each case.

SUMMARY OF THE INVENTION

The present ~~The~~ invention is based on the object of increasing the ~~fitting~~ **equipping** performance with a low constructional outlay.

This object is achieved by the ~~invention in accordance with claim 1~~ **equipping head with a storage element according to the present invention**. The storage element can be designed to be sufficiently large that it is able to accommodate a large number of components. In this case, the ~~fitting~~ **equipping** head in the area of the feed devices **picks** ~~will~~ ~~pick~~ up components until the storage element has been filled. Then, the ~~fitting~~ **equipping** head moves over the substrate to be fitted, where the gripper removes the components from the storage element and places them successively onto the ~~envisaged fitting~~ **proper** locations. ~~A fitting~~ **An equipping** head of this type needs only a single gripper for filling and emptying the storage element. Since, ~~in this case,~~ only low relative movements take place between the gripper and the storage element, these operations are able to proceed ~~at a high clock rate~~ **quickly**, similar to that in the turret head.

In mechanical terms, the storage element can be configured ~~largely~~ more simply than the grippers of the turret head. In addition, ~~it~~ **the storage element** can be kept so large that it accommodates a considerably larger number of components, as a result of which the ~~fitting~~ **equipping** head has to move less often between the feed devices and the substrate.

~~Advantageous developments of the invention are identified in claims 2 to 18:~~

~~The development as claimed in claim 2 means that~~ **In one embodiment,** the components can be transported between the gripper and the storage element in simple movement sequences.

The pivoting part as ~~claimed in claim 3 means that the~~ **provided in a further embodiment provides an easy** relative movement of the gripper between the placement and the transfer position ~~can be implemented in a simple way:~~.

~~As a result of the development as claimed in claims 4 and 5, the component can be fetched in a simple way~~ **In another embodiment, the component can easily be fetched** from the feed devices, transferred to the storage element, removed from the latter, and placed onto the substrate.

~~As a result of the development as claimed in claim 6~~ **In a further embodiment**, the transfer between the gripper and the storage element can be controlled in such a way that the component is held safely in every phase.

~~As a result of the development as claimed in claim 7~~ **In another embodiment**, the action of positioning the components ~~on the sliding part~~ is simplified. It is possible to ~~assign~~ **use** a sensing device, for example an optical sensing device, ~~for determining~~ **to determine** the position of the components to one of the stepping positions ~~of the sliding part~~. Since the transferring of the components from the sliding part to the gripper is carried out in a defined manner, it is possible to use the position data obtained from the sensing device to correct the angle and position of the components.

~~The~~ **Also,** suction openings ~~as claimed in claim 8~~ **can be provided with the sliding part so as to** constitute simple holding means for the components on the sliding part. **This provides a way for** ~~The developments as claimed in claims 9 and~~

~~10 mean that~~ the components ~~can~~ **to** be held and transferred on the sliding part in a simple way.

The **sliding part can also be provided in the form of annular design being rotatably mounted, which readily permits** ~~annular sliding part as claimed in claim 11 constitutes a structural part which is simple and simple to operate.~~

~~The arrangement as claimed in claim 12 readily permits the~~ vertical placement of the components onto the storage spaces or onto the substrate.

~~As a result of the development as claimed in claim 13, the alternating operations when fetching the~~ **Accordingly, the operations of fetching** components from the feed devices and ~~when~~ filling the storage element can be accelerated, in that in each case, one of the grippers is located in the fetch position and another **gripper is located** in the transfer position. In the same way, the actions of emptying the storage element and ~~fitting~~ **equipping** the substrate ~~can be~~ **are also** accelerated.

~~The pivoting part as claimed in claim 14 needs only~~ **In another embodiment,** two grippers~~, which,~~ in a pendulum-like movement, alternately assume the placement position and the transfer position. In this case, however, each individual gripper must be assigned its own transfer position. In the case of a sliding part which is concentric with the placement position, this can be implemented in a straightforward manner by the two transfer stations being located diametrically opposite each other. A filling cycle can then be carried out with half a revolution of the sliding part, each of the two grippers filling one half of the ring.

~~The rotor as claimed in claim 15 means that~~ **In another embodiment,** the pivoting part can be indexed in a rotational movement without any change of direction. Since, ~~then,~~ the grippers are no longer primarily used for storing the components, ~~their~~ **the** number **of grippers** can be reduced to the number of working stations provided without any ~~costs~~ **loss** in ~~terms of~~ performance. If, ~~for example,~~ in addition to ~~the~~ **a** placement station and ~~to the~~ **a** transfer station, a sensing and a rotation station are further provided, only four grippers ~~are then needed.~~ **would be needed.**

~~As a result of the development as claimed in claim 16, the components are~~ **In another embodiment, the working stations are being provided along a circulation path of the grippers, on a stator of the equipping head. Here, at least one of the working stations form the transfer station. Accordingly, components can be** transferred at the clock rate of the ~~fitting~~ **equipping** head without any loss of time.

~~The arrangement as claimed in claim 17 makes it~~ **By placing a sensing station between the transfer station and the placement station, it is** possible to perform ~~the~~ positional control and position correction of the components following removal from the storage element, and directly before the last handling step of the placement onto the substrate.

By ~~means of the~~ **using an** additional storage element ~~as claimed in claim 18,~~ ~~the,~~ storage capacity can be increased considerably. In the case of a turret-like ~~fitting~~ **equipping** head, it is easily possible to assign ~~the~~ **a** second transfer station to a previously unused holding station.

~~In the following text, the invention will be explained in more detail using an exemplary embodiment illustrated in the drawing, in which:~~ **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 shows in schematic form ~~a fitting~~ **an equipping** head having two grippers ~~in a V shape in relation to each other,~~;

Figure 2 shows the ~~fitting~~ **equipping** head according to figure 1 in a different working phase~~,~~;

Figure 3 shows ~~in schematic form~~ a side view of ~~another fitting~~ **an equipping** head with grippers arranged in ~~the manner of~~ a turret~~,~~; and

Figure 4 shows an end view of the ~~fitting head according to figure 3.~~ **equipping head according to Figure 3.**

~~According to figure 1, a fitting~~ **BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS**

As shown in Figure 1, an equipping head 1 can be moved in the direction of the indicated arrows X and Y in two coordinate directions by means of a positioning system (not illustrated), ~~for example~~ between feed devices and a substrate. Feed devices of this type have, ~~for example,~~ mutually parallel component tapes 2, having pockets in which electronic components 3 are ~~accommodated~~ **held**. By means of stepwise displacement of the component tape 2, the pockets can be displaced into a fetch position, in which ~~the~~ **a** respective component 3 can be removed from the component tape 2 in the indicated vertical arrow direction by a gripper 4, ~~for example by means of~~ **by** suction.

~~The gripper~~ **Gripper** 4 is guided in a pivoting part 5 and can be displaced in the fetch direction, perpendicular to the plane of movement. It is lowered with its holding end onto the component, which is lying in a ready position and arrives in the active range of a suction channel of the gripper **4**. By means of withdrawing the gripper **4**, the component 3 is removed from the component tape and lifted into the transport position illustrated **in Fig. 1**.

The pivoting part 5 can be pivoted about a horizontal axis 6 in accordance with the circular arrow S. It has a second gripper 4, which is arranged in a V-shape with respect to the other gripper 4 in the pivoting plane of the pivoting part 5, in such a way that the longitudinal axes of the grippers 4 meet at the center of the axis 6.

In addition, the ~~fitting~~ **equipping** head 1 has an annular storage element 7~~,~~ which is concentric with the vertical gripper 4, and is provided with an annular sliding part 8~~, which is~~ mounted on a stationary annular part 9 of the storage element 7, such that it can be rotated in the direction of rotation arrow D. A free inner side of the sliding part 9 is of conical design and provided with suction openings 10, which are arranged such that they run around at uniform pitch spacings. ~~These suction~~ **Suction** openings 10 define storage spaces 11 for the components 3.

~~The pivoting~~ **Pivoting** part 5 can be pivoted between stops 12 belonging to the ~~fitting~~ **equipping** head 1 in such a way that in each case, one of the grippers 4 is located in the vertical fetch position, and the other gripper is located in an oblique transfer position~~,~~ in which it is assigned to a transfer station 19 of the ~~fitting~~ **equipping** head 1. At the same time, the sliding part 8 is rotated into a position ~~in which it is~~

assigned to one of the free storage spaces 11, likewise belonging to the transfer station 19~~, the gripper 4 being~~. **Gripper 4 is** oriented perpendicular to the storage space 11. By means of a vertical placement movement of ~~the~~ gripper 4, the previously fetched component 3 can be deposited on the storage space 11 of the sliding part 8.

_____During these transfer operations, ~~the~~ pressure relationships in the suction opening 10 and the suction channel of the gripper 4 can be controlled in such a way, that the component 3 is held securely in every phase and can be transferred without being offset laterally.

By means of pivoting the pivoting part 5, the free gripper 4 can then be pivoted into the fetch position, **and** the other gripper 4 ~~moving~~ **is moved** into a different transfer position, in which it is assigned to a further transfer station 19~~, which is~~ located diametrically opposite the other. ~~The sliding~~ **Sliding** part 8 is cycled in such a way that in each case, one of the storage spaces 11 is located in the transfer station 19, **and** the storage element 7 **is** already ~~having been~~ completely filled after half a revolution of the sliding part 8.

Then, according to ~~figure~~ **Figure** 2, the ~~fitting~~ **equipping** head 1 can be moved in ~~a fitting~~ **an equipping** area of the ~~fitting~~ **equipping** apparatus above a substrate 13, onto which the component 3, in a movement sequence which is the reverse of that for filling, ~~are~~ **is** removed successively from the storage element 7 and placed onto the substrate 13.

According to ~~figures~~ **Figures** 3 and 4, a large number of grippers 14 ~~is~~ **are** arranged on a rotor 15~~, which is~~ mounted on a stator 16 of another ~~fitting~~ **equipping** head 17, such that it can be rotated step by step. Various angular positions of the

grippers 14 are associated with different working stations. These are, ~~for example,~~ constructed as a placement station 18, a transfer station 19, a sensing station 20, and a rotating station 21.

In the placement station 18, the components 3 are removed from the component tape 2 and, in two steps, are pivoted as far as the transfer station. Located at their level is the annular storage element 7 having the conical sliding part 8, on whose storage spaces 11 the components 3 can successively be placed. After these locations have been filled, ~~the~~ grippers 14 of the rotor 15 can be populated with additional components 3 in a further cycle~~, those~~ **such** components ~~which are~~ **may be** less suitable for intermediate storage in the storage element ~~7 being those considered in particular.~~ **7than the components 3 previously considered.**

~~The fitting~~ **Equipping** head 17 then moves until it is **in a position** above the substrate 13 to be fitted, ~~into the position~~ **as** shown in ~~figure~~ **Figure** 4. Here, ~~first of all~~ the components 3 located on the grippers 14 are placed onto the substrate 13 in the placement station 18. During this cycle, the precise position of the components 3 is determined in the optical sensing station 20. In the following rotation station 21, the angular position of the components 3 is corrected by rotating the gripper 14 about its longitudinal axis, which is arranged such that it is vertically radial with respect to the axis of rotation of the rotor **15**.

As soon as grippers 14 which have become free reach the transfer station 19, they successively remove ~~the~~ components 3 from the synchronously corotating sliding part 8 of the gripper 7 and, after passing through the sensing station 20 and rotation **the**

station 21, ~~likewise~~ place said components **3** onto the substrate 13. After all the components 3 have been placed onto the substrate 13, **equipping** ~~the fitting~~ head 17 can be moved over the feed devices for a new fetch cycle.

It is possible to provide~~, in~~ the ~~fitting~~ **equipping** head 17, **with** at least one further storage element 7 and one further transfer station, as indicated **by** dash-dotted **line** in ~~figure~~ **Figure** 4. ~~By this means~~ **Thus**, the storage capacity of the ~~fitting~~ **equipping** head 17 can be increased appropriately.

Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.--